FUTURE OF FOOD:

WHY MILLETS MATTER - CONNECTING HEALTH, ECONOMY, AND SUSTAINABILITY

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Introduction: *rethinking what we eat for a sustainable tomorrow*

Food is more than just nourishment; it shapes health, livelihoods, and ecosystems. Yet, the global food system today faces an unprecedented crisis. While one part of the world battles hunger, another struggles with obesity and lifestyle-related diseases (Thakur et al., 2024). At the same time, farmers are facing climate-induced crop failures, and our agricultural systems are depleting natural resources at alarming rates. In this complex web of nutritional insecurity, economic instability, and environmental degradation, a set of ancient, resilient grains known as millets are emerging as a beacon of hope. Once regarded as "poor man's food," millets are now being rebranded as "smart foods" good for you, good for the farmer, and good for the planet. They offer a unique blend of nutrition, adaptability, and ecological harmony, making them indispensable for the future of food.

Millets: *the forgotten grains with a glorious past*

Millets are among the earliest domesticated crops known to humankind, cultivated for over 5000-6000 years across Asia and Africa (Winchell et al., 2018). They were the primary staple before rice and wheat took over during the Green Revolution. India has a rich history of millet cultivation from pearl millet (bajra) and finger millet (ragi) to small millets like foxtail, barnyard, kodo, proso, and little millet. However, modernization of agriculture and consumer preference for polished rice and refined wheat led to a gradual decline in millet cultivation. The share of millets in India's total cereal production fell from 40% in the 1950s to less than 10% by the early 2000s. Now, driven by rising health awareness and the need for climate-smart agriculture, millets are making a remarkable comeback. The United Nations declared 2023 as the International Year of Millets on India's proposal has put these grains back in the global spotlight (Jadhav et al., 2024).

Health: rediscovering nature's nutritious grains

The modern diet, dominated by processed foods and refined cereals, is a major cause of malnutrition and chronic diseases. Millets, in contrast, are nutritionally superior and can play a key role in combating both undernutrition and overnutrition. Millets are rich in protein, dietary fiber, essential amino acids, and micronutrients such as calcium, iron, zinc, and magnesium (Ingle et al., 2023). For instance:

- **Finger millet (ragi)** contains nearly 10 times more calcium than rice or wheat ideal for bone health.
- **Pearl millet (bajra)** is high in iron and zinc, combating anaemia.
- **Foxtail millet and little millet** have low glycaemic indices, beneficial for diabetes management. Their high fibre content aids digestion, prevents constipation, and contributes to a feeling of satiety reducing overeating and obesity risk.

Tackling lifestyle diseases

Globally, the incidence of diabetes and cardiovascular diseases is rising at an alarming rate. Millets help regulate blood sugar levels and lower cholesterol, making them an excellent dietary choice for managing metabolic disorders. Research from ICRISAT and other institutions has shown that millet-based diets can reduce blood glucose levels by up to 17% compared to refined cereal diets (Rathor, 2021). Being naturally gluten-free, millets are also suitable for individuals with celiac disease or gluten intolerance. They serve as a healthier alternative to refined flours in bakery items, snacks, and processed foods. In many developing countries where malnutrition and micronutrient deficiencies persist, millets offer a cost-effective way to deliver essential nutrients. Incorporating them into midday meal programs, Anganwadi nutrition schemes, and school feeding initiatives can help combat hidden hunger among children and women. In essence, promoting millets is not merely a dietary preference; it is a public health strategy that addresses both undernutrition and lifestyle-related diseases simultaneously.

Economy: reviving rural livelihoods and farmer prosperity

Millets are not only nutritious but also economically empowering, especially for smallholder farmers in dryland regions.

Low input, high resilience

Unlike rice and wheat, millets thrive on marginal lands with low water, minimal fertilizer, and very little pesticide requirements. Their ability to grow in poor soils and withstand drought makes them a lifeline for farmers in semi-arid tropics like India and sub-Saharan Africa (Mukherjee et al., 2025). For instance, while rice needs around 2,500 liters of water to produce one kilogram of grain, millets can yield the same quantity with less than 500 liters (Bouman, 2009). This water-use efficiency makes them ideal for water-scarce regions. Because of their hardy nature, millets minimize crop failure risks during erratic rainfall and high-temperature spells. Lower production costs mean farmers retain higher net incomes even when market prices are moderate.

Creating new value chains

The growing consumer demand for healthy and organic foods is driving the establishment of millet-based industries. Startups and food companies are innovating with millet-based products from in-

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stant mixes, noodles, and breakfast cereals to cookies, energy bars, and beverages. This expanding millet value chain is creating jobs in processing, packaging, and marketing, contributing to rural entrepreneurship. The government's initiatives, such as the "Millet Mission" and "Smart Food Campaign," are promoting these value-added opportunities (Tiwari et al., 2024).

Enhancing export potential

India, being the largest producer of millets globally, is well-positioned to lead the international millet market. Export demand for organic and processed millet products is growing in North America, Europe, and the Middle East. With proper branding, certification, and quality assurance, millets could become the next global superfood export from India.

Sustainability: millets as climate-smart crops

In an era of accelerating climate change, millets represent the essence of climate-smart agriculture. They thrive in arid and semi-arid regions with rainfall as low as 250–400 mm and temperatures exceeding 40°C. Their ability to withstand drought, heat, and poor soil fertility makes them ideal for climate adaptation. Millets have a low carbon and water footprint, contributing to environmental sustainability. While rice cultivation emits methane and consumes vast amounts of groundwater, millets are naturally energy-efficient and require no standing water. Research suggests that replacing 20% of rice or wheat with millets could reduce water demand by 33% and a significant amount of emissions of greenhouse gas (Davis et al., 2018; Tata Power, 2025). They also improve soil health and biodiversity. Grown with minimal chemical inputs, millets support microbial activity, prevent erosion, and enhance organic matter in soils. Their diverse species add stability to farming systems and foster ecological balance. By aligning with multiple UN Sustainable Development Goals (SDGs), including Zero Hunger (SDG 2), Good Health and Well-being (SDG 3), Climate Action (SDG 13), and Responsible Consumption and Production (SDG 12) (Smaller Footprint, 2024). Millets are more than crops; they are instruments of sustainability that connect ecology with economy.

Global revival: from ancient traditions to modern tables

Millets are no longer confined to traditional diets; they are becoming a global food movement. Governments, researchers, chefs, and entrepreneurs are working together to mainstream these ancient grains and position them at the centre of sustainable food systems.

Policy Momentum and Global Partnerships

A strong policy push has accelerated the millet revival. The Indian government has integrated millets into Public Distribution Systems (PDS) and Integrated Child Development Services (ICDS), ensuring their inclusion in daily diets across rural and urban areas (Smaller Footprint, 2024). Events such as the Global Millets (Shree Anna) Conference 2023 have further amplified their visibility, establishing India as a global hub for millet promotion.

This momentum is also supported through international collaborations. Countries in Africa, including Nigeria, Ethiopia, and Kenya, along with several Asian nations, are partnering with India to promote millet-based farming and nutrition. Global agencies such as FAO and IFAD have recognized millets as essential crops for climate adaptation, nutrition improvement, and smallholder livelihood resilience, reinforcing their significance on the world stage.

CULINARY REINVENTION AND SCIENTIFIC INNOVATION

Parallel to policy advances, the culinary and research sectors are driving innovation. From five-star hotels to local cafés, millets are being creatively reintroduced in modern cuisines. Dishes like millet risottos, dosas, and desserts are now gaining popularity on global menus. This urban acceptance is crucial not only for consumer awareness but also for stimulating demand that encourages farmers to expand millet

cultivation. On the research front, institutions like International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Indian Council of Agricultural Research (ICAR), and State Agricultural Universities (SAUs) are developing high-yielding, biofortified, and climate-resilient millet varieties. Advances in genomics, breeding, and post-harvest processing are improving grain quality, shelf life, and product diversity, making millets more appealing to modern consumers. Together, these innovations bridge traditional wisdom with scientific progress, ensuring that millets evolve from ancient heritage grains to future-ready foods.

THE ROAD AHEAD: BUILDING A MILLET-BASED FUTURE

To ensure the millet movement continues beyond short-term campaigns, a multi-dimensional and sustained approach is essential, combining consumer awareness, market development, research support, and strong policy backing.

DRIVING AWARENESS AND STRENGTHENING VALUE CHAINS

Long-term success depends on changing perceptions and creating steady consumer demand. Public awareness campaigns highlighting the health, nutritional, and environmental benefits of millets can inspire lifestyle shifts and build lasting acceptance. Introducing millet-based meals in schools, hospitals, canteens, and restaurants can normalize their consumption across generations. Equally important is building efficient value chains that connect farmers to markets. Investments in post-harvest infrastructure, including dehulling, grading, milling, and packaging units, are vital to maintain quality and ensure competitiveness. Strengthening farmer-producer organizations (FPOs) can integrate smallholders into organized supply systems, improve price realization, and create rural employment opportunities. Together, awareness and infrastructure development form the backbone of a sustainable millet economy from farm to fork.

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RESEARCH, INNOVATION, AND POLICY SUPPORT

Continuous research and extension will be critical to improve productivity, processing efficiency, and consumer appeal. Efforts to develop high-yielding, biofortified, and climate-resilient varieties, along with innovations in product formulation and shelf life, can help millets compete with mainstream cereals. Training programs for farmers, entrepreneurs, and food processors can further bridge the gap between production and processing. At the policy level, integrating millets into national frameworks such as climate adaptation plans, nutrition missions, and public procurement systems will solidify their role in food security strategies. Institutionalizing millet inclusion in government programs ensures long-term commitment beyond international observances or short-term projects (GOI-PIB, 2025). A coordinated approach linking science, markets, and governance will pave the way for a truly millet-based future, one that nourishes people, supports farmers, and sustains the planet.

CONCLUSION: MILLETS AS THE GRAINS OF THE FUTURE

Millets embody the perfect synergy between tradition and technology, health and sustainability, people and the planet. In a time when global food systems are under stress, these humble grains offer a roadmap to resilience. By reviving millet cultivation and consumption, we can:

- Nourish populations with balanced, nutritious diets,
- Empower farmers with sustainable income opportunities, and
- Protect natural resources for future generations.

The future of food does not always lie in discovering something new sometimes, it lies in rediscovering the wisdom of the past. Millets, once forgotten, are now the grains of hope, shaping a healthier, greener, and more sustainable future for all.

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